Climate Change and Child Health

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Source: NASA

Objectives

- Participants will be able to
  - describe some of the causes of climate change
  - explain some of the foreseeable impacts on human health and specific impacts on children
  - recommend lifestyle changes that individuals may make to address climate change
  - discuss the importance of policy change to deal with the problem of climate change

What is “Climate Change”?

- Climate=average weather over period of time, classically 30 years.
- Highly complex system of interacting components, including earth’s orbit, internal dynamics and external drivers.
- Weather – is it hot/cold, dry/wet, calm/stormy over short period of time

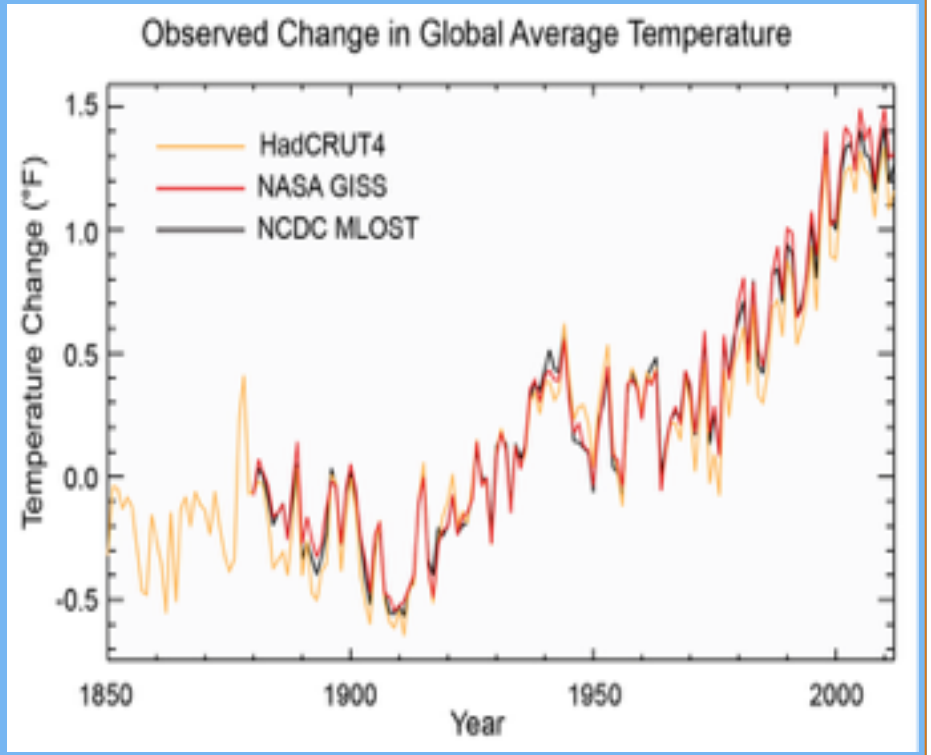
Photograph by Warren Faidley / Weatherstock

What is “Climate Change”?

- Has changed throughout Earth’s history.
- Last ice age about 14,000 years ago. Gradually warmed over 5,000 years, then stable until about 100 years ago.
- Over past 100 years, global temperature has changed much more rapidly than in the past.

Climate Change is Real

- Warming of the planet is unequivocal.
- The global average temperature increased 0.85 (0.65-1.06)°C between 1850-2012.
- Much of this increased heat has been absorbed by the ocean.
- 10 warmest years in the instrumental record, with the exception of 1998, have occurred since 2000.
- 2014 hottest year recorded.
- Inertia in the climate system means change will continue for decades after successful control of greenhouse emissions
- Extent of health impacts will depend on our ability to design and implement effective adaptation measures



(NASA/NOAA)

What are the Impacts of Climate Change?

- Rising temperatures are causing broad range of climactic changes:
  - Worsening heat waves
  - Shrinking ice sheets
  - Rising Sea Levels
  - Worsening storms
  - More frequent/severe wildfires.
  - More extreme precipitation events/flood
  - Worsening drought

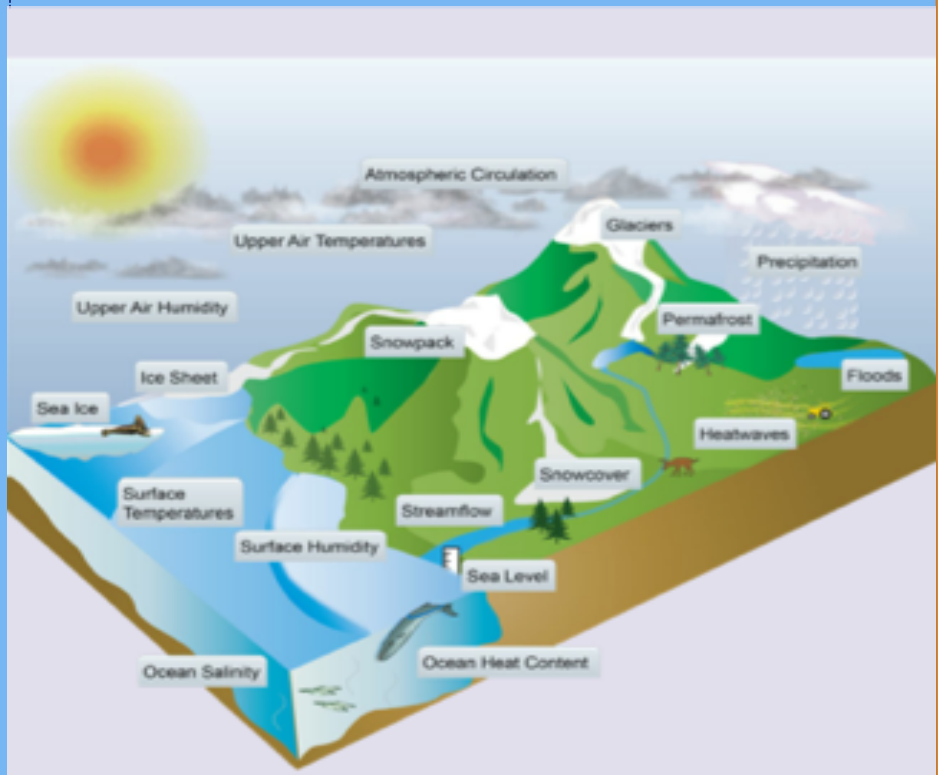


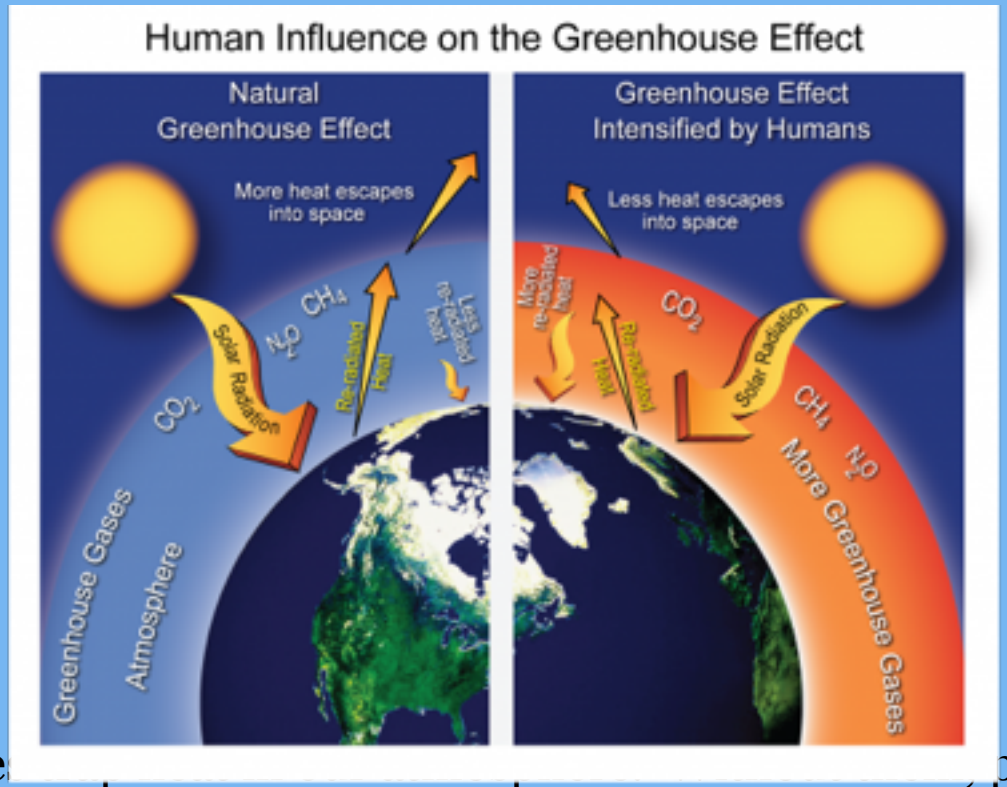
Image Source: NCA

Consensus on Climate Change

97% climatologists and virtually every relevant scientific body in the world agree that this temperature change is the result of human generated greenhouse gas emissions and cannot be explained by natural forces.

NASA, NOAA, American Association for the Advancement of Science, IPCC, National Academy of Sciences, American Chemical Society, American Geophysical Union, American Institute of Biological Sciences, American Meteorological Society, American Society of Agronomy, American Society of Plant Biologists, American Statistical Association, Association of Ecosystem Research Centers , Botanical Society of America, Crop Science Society of America , Ecological Society of America, Natural Science Collections Alliance , Organization of Biological Field Stations, Society for Industrial and Applied Mathematics, Society of Systematic Biologists, Soil Science Society of America, University Corporation for Atmospheric Research

The Greenhouse Effect

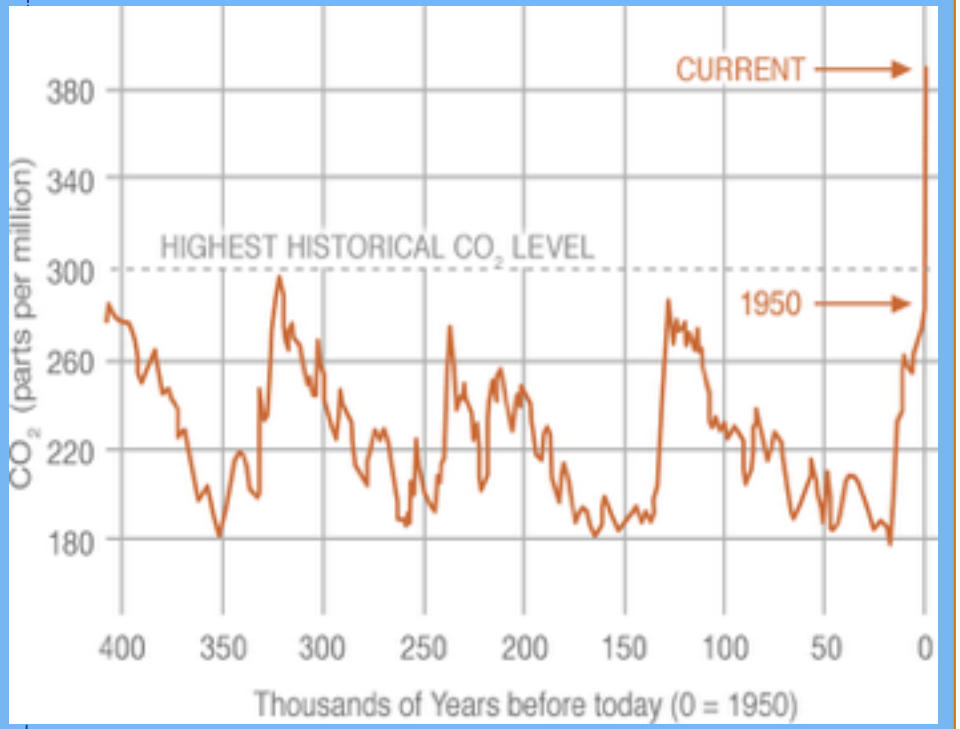


Source: NCA

- Greenhouse gase[illegible] planet would be ball of ice.
- Increasing concentrations trap more heat, and cause the Earth to warm.

Greenhouse Effect & Atmospheric CO_2

- Burning of coal, oil and gas, and deforestation has led to rapid change in atmospheric CO_2.
- 1900: *about 280 ppm*
- 2013: *hit 400 ppm*



Data from reconstruction from ice cores.
Source: NOAA

Climate Change and Child Health

- Health of children and their environment are not exclusive but inextricably linked.
- Children rely on the stability of natural systems for their health, safety and prosperity.

Youth delegates show their finalized Declaration during the Children's Climate Forum in Copenhagen.

Climate Change and Child Health

- Children are the most vulnerable group to climate associated health impacts.
  - Higher minute ventilation
  - Greater volume food/water per unit body wt
  - Physiologic/cognitive immaturity
  - Windows of vulnerability
  - Greater interaction with outdoor environment

- A woman and her baby sit atop a raft as they are rescued from rising floodwater by their neighbors in Pasig City, Manila.
-

Climate Change and Child Health

- Estimated 88% of the existing global burden of disease due to climate change occurs in children under the age of 5. (Zhang, *J Environ Health* 2007)
- Children in the world's poorest countries, where the disease burden is already disproportionally high, are most affected by these impacts. (Haines, *Lancet* 2006)

Climate Change and Child Health

Climate change affects child health through:

1) Increased heat related illness

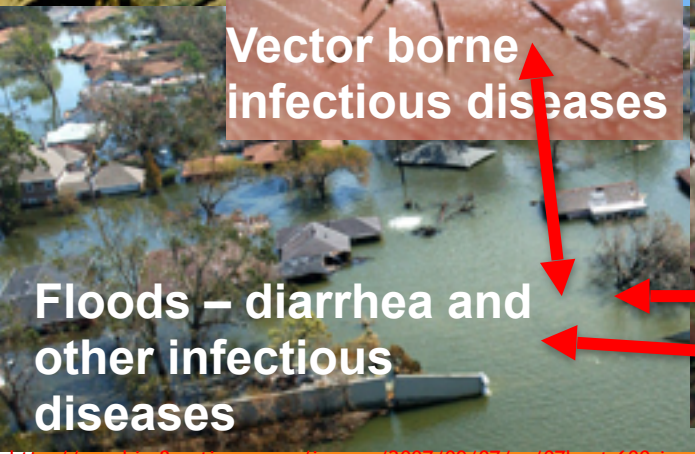
2) Impacts on air quality

3) Altered disease patterns of some climate sensitive infections

4) Physical and mental health impacts of extreme weather events

5) Food and water insecurity

Factors Interact



http://graphics8.nytimes.com/images/2007/09/07/us/07heat.600.jpg; http://eofdreams.com/data_images/dreams/draught/draught-01.jpg
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http://www.kmzu.com/wp-content/uploads/2014/03/Severe-Weather.jpg; http://www.ready.gov/sites/default/files/Floods%201.1.1.0%20Tab%202%20of%204_1.jpg; http://wwwnc.cdc.gov/travel/

Increased Heat Illness

- Extreme heat is the leading cause of environmental deaths in the U.S., killing more people than hurricanes, lightning, tornadoes or floods combined. (Voorhees, *Environ Sci Technol* 2011)
- Is "virtually certain" that will be warmer/more frequent hot days/nights this century. (IPCC, WGI 2013)
- Illness and death from heat exposure is expected to increase. (CDC, Climate Change and Extreme Heat Events)
- Elderly at greatest risk.
- High risk groups include infants < 1 year, and high school athletes, particularly football players.

Heat Illness in Infants < 1 year

- Infants are uniquely vulnerable group to heat-related mortality. (Basagna, *Epidemiology* 2011; Basu, *Am J Epidemiol* 2008)
- 2007 MIT study: By end of 21st century, under "business as usual" scenario, infant mortality will increase by 5.5% in females and 7.8% in males due to heat-related deaths.
- (Deschenes, 2007)

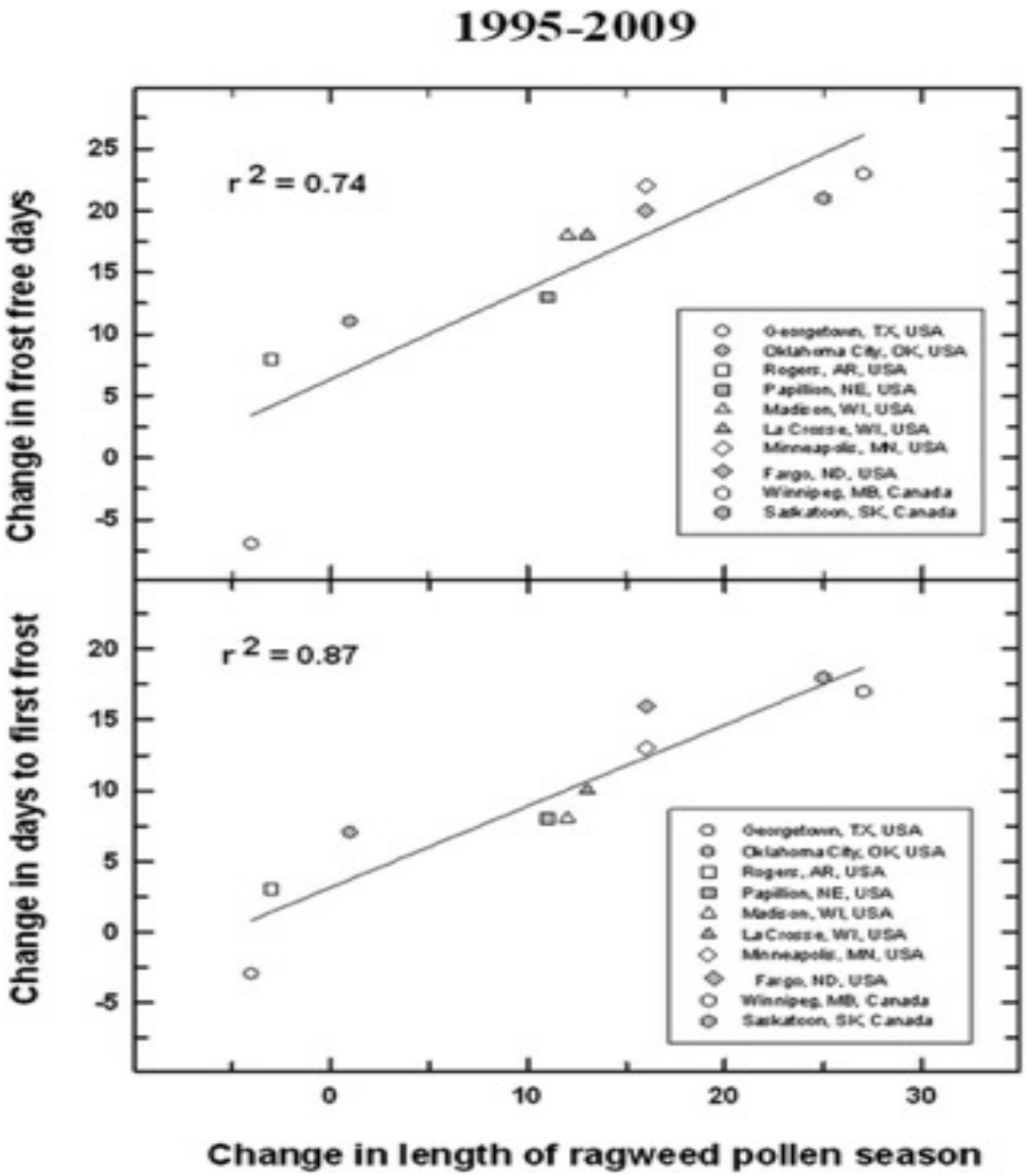
phn.cdc.gov

Heat Illness in U.S Student Athletes

- > 1/3 U.S. ED visits for exertional heat injury are in teenage male athletes. (MMWR 2011)
- Heat illness is a leading cause death/disability in high school athletes. >9,000 illnesses/year. (MMWR 2010)

Allergic Rhinitis

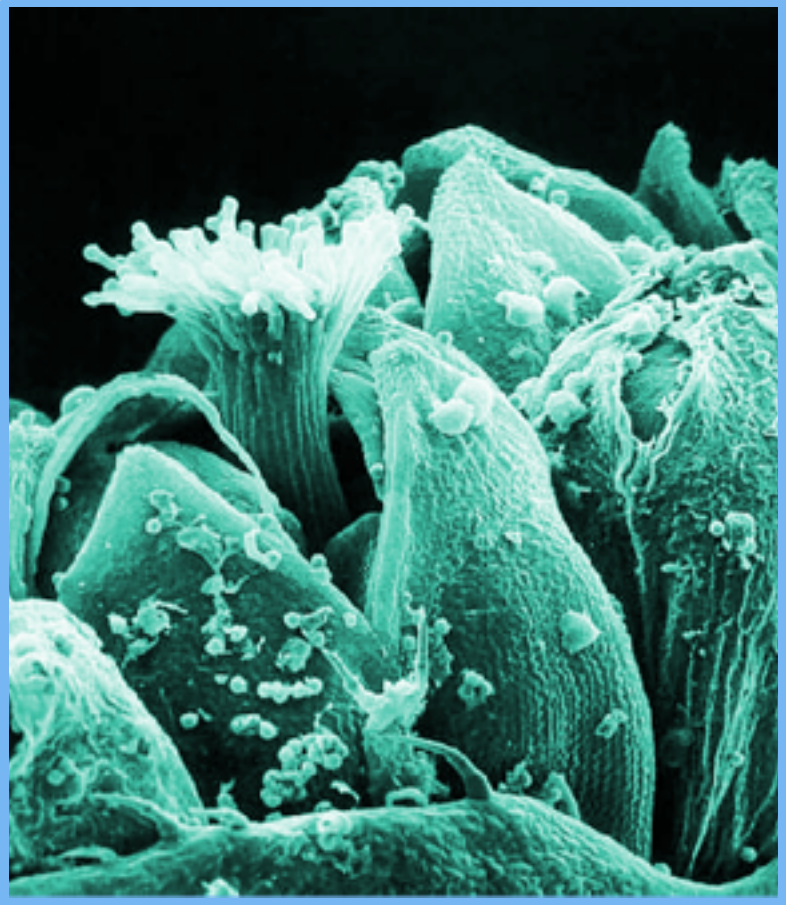
- Affected 9% of American children in 2012.
- Climate change impacts allergies through:
  - Delayed First Frost
  - Earlier Spring Thaw
  - Higher atmospheric CO_2 alters plant pollen production.



Ziska L et al. PNAS 2011;108:4248-4251

Climate Change and Allergic Rhinitis

- Ragweed plants produce higher pollen counts when grown in conditions of increased temperature and CO_2. (Singer, *Funct Plant Biol* 2005)
- Plants grown in today's CO_2 concentrations produce about twice as much pollen as in CO_2 of last century. (Ziska , *World Resource Rev* 2000)



Electron Micrograph of ragweed plant.

Source: phil.cdc.gov

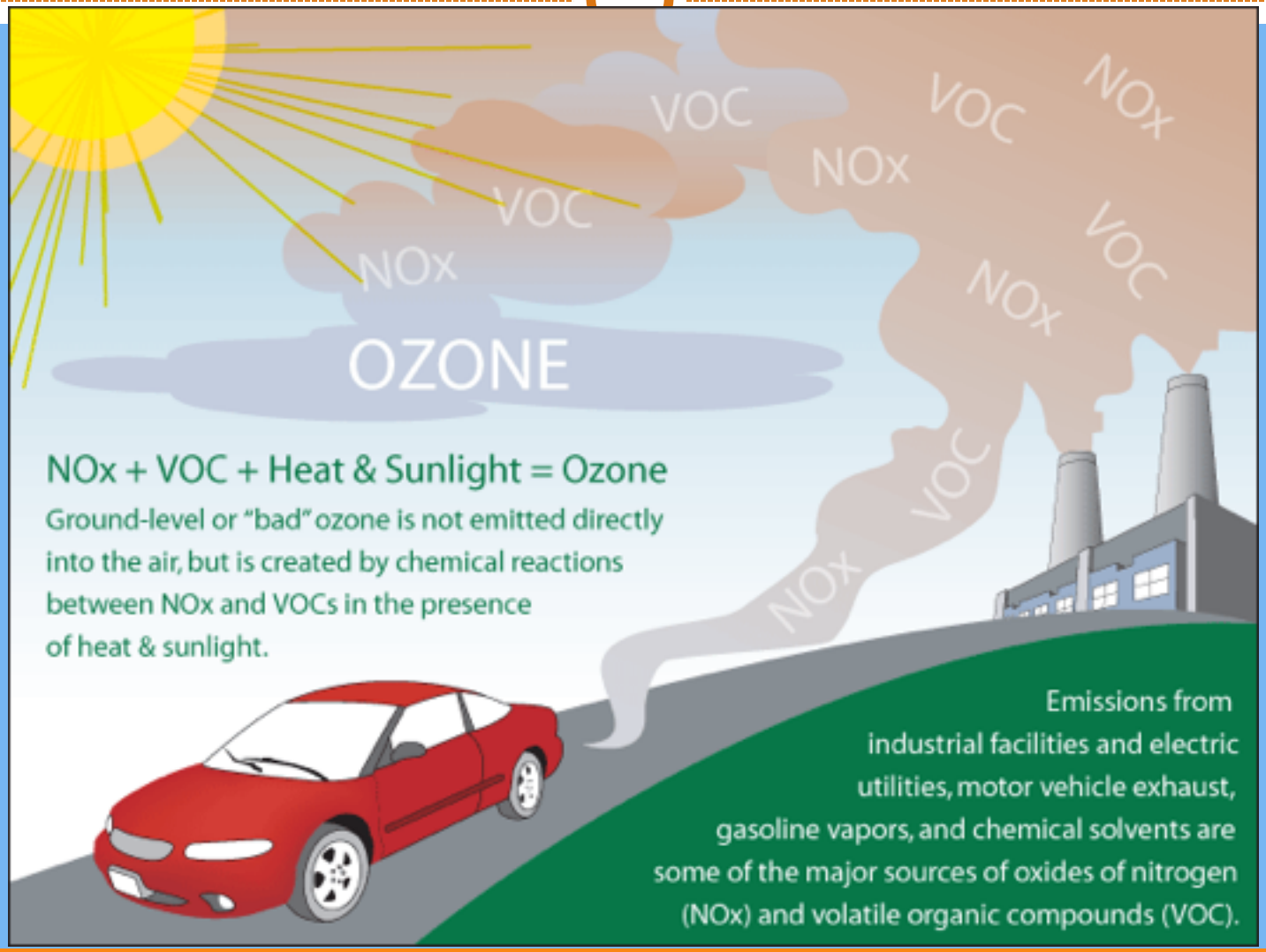
Climate Change and Asthma

Climate Change impacts child asthma:

1) Worsening of seasonal allergies.

2) Increased concentrations of ground level ozone.

Climate Change and Asthma



Source: EPA, airnow.gov

Ozone and Asthma

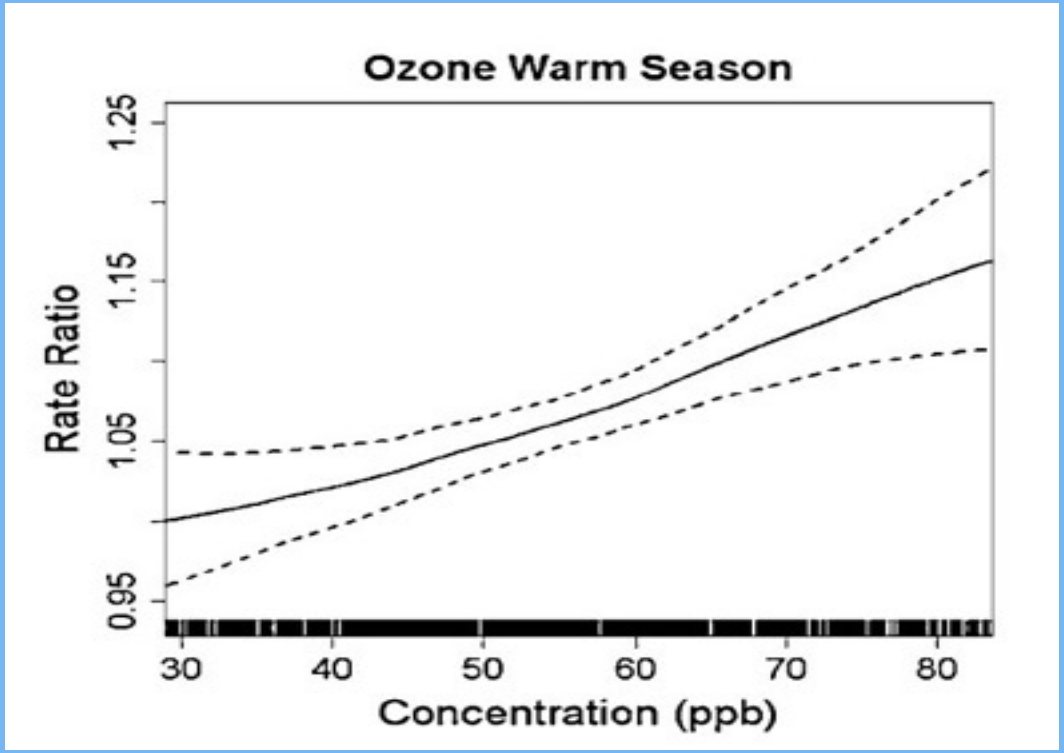
- Inhaling Ozone Causes:
  - Decreased lung function
  - Coughing, burning and shortness of breath
  - Inflammation and swelling of airways
  - Constriction and air trapping
  - Asthma attacks

Air Quality Index for Ozone

Index Values (Conc. Range)	Air Quality Descriptors	Cautionary Statements for Ozone
0 – 50 (0-60 ppb)	Good	**No health impacts are expected when air quality is in this range.**
51 – 100 (61-75 ppb)	Moderate	**Unusually sensitive people should consider limiting prolonged outdoor exertion**
101 – 150 (76-104 ppb)	Unhealthy for Sensitive Groups	**Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion**
151 – 200 (105-115 ppb)	Unhealthy	**Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children should limit prolonged outdoor exertion.**
201 – 300 (116-374 ppb)	Very Unhealthy	**Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.**

Ozone and Pediatric Asthma

Dose-response estimate (solid line) and twice-standard error estimates (dashed lines) for association between 3-day moving average of ozone concentration and emergency department visits for pediatric asthma.
(Strickland, *Am J Respir Crit Care Med* 2010) (Data from Atlanta Georgia, 1993-2004)



Climate Change and Asthma

- Ozone concentrations in U.S. may increase by 5-10% by 2050 due to climate change alone.
- (Kinney, *Am J Prev Med* 2008)

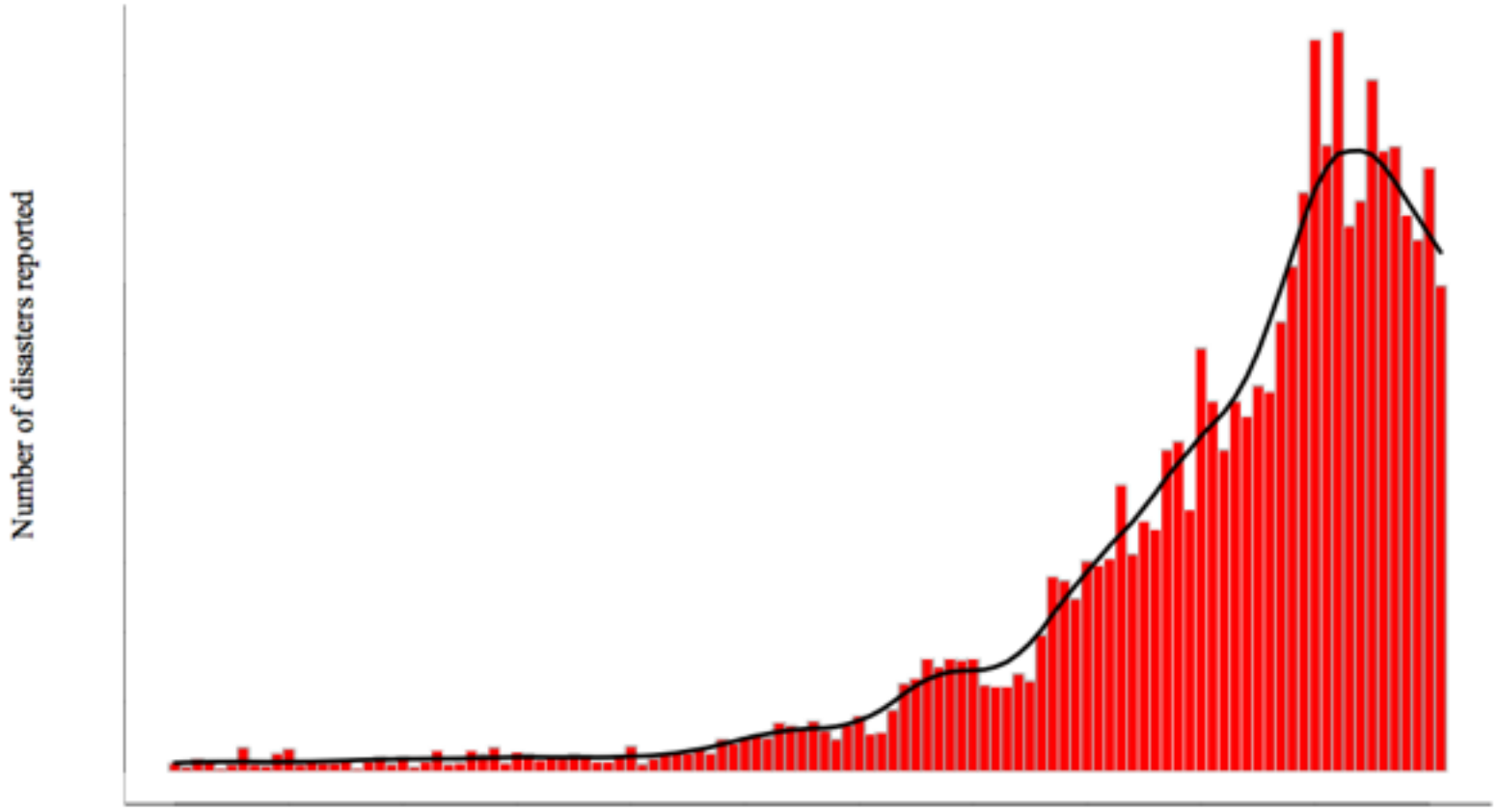
- Climate change associated increase in ground-level ozone projected to increased child asthma ER visits in New York City by 5-10% in 2020.
- (Sheffield, *Am J Prev Med* 2011)

Climate Change and Natural Disasters

- Three times as many events occurring between 2000 and 2009 as did between 1980 and 1989.
- The scale has increased, due to deforestation, environmental degradation, urbanization and intensified climate variables. (Leaning, *NEJM* 2013)

A large, intense Hurricane Katrina heading for a Gulf Coast landfall. Katrina was the costliest hurricane to ever hit the US. Source: NASA

Extreme Weather Events



Source: EM-DAT, International Disaster Database, Belgium

Children and Natural Disasters

- Extreme weather events place children at risk of:
  - Injury and death
  - Loss of /separation from caregivers
  - Exposure to infectious diseases post disaster
  - Uniquely high risk of mental health consequences.

New Orleans, La. (Aug 31, 2005) A man carries a baby through the flooded streets of New Orleans.
U.S. Navy photo (RELEASED)

Hurricane Katrina

- *>5,000* children separated from their families.
- Last child reunited 6 months after the event.
- *>34,000* calls made to missing and exploited children hotline.
- *400* children rescued from flooded homes.
- *11,000* children placed in Convention Center/ Superdome.
- *200,000-300,000* children evacuated and relocated.

Source: National Commission on Children and Disasters. *2010 Report to the President and Congress*

Source: The National Center for Missing & Exploited Children/AP

Hurricane Katrina

- Displaced students in Louisiana public schools on average performed worse in all subjects and grades compared to other students. (National Commission 2010)
- Serious emotional disturbance persisted in 11.5% of children and adolescents three years after the hurricane. (McLaughlin, *J Am Acad Child Adol Psych* 2010)
- PTSD symptoms persisted in 46% of 4th through 6th graders 33 months post hurricane. (Moore, *Child Psych Hum Dev* 2010)

Climate Change and Extreme Weather

Gradual changes due to extreme weather threaten the social foundations of child mental and physical health and well-being.

May become severe if CC remains unchecked.

- Sea level rise impacts on agricultural/tourism/indigenous communities
- Decreased biologic diversity
- Water Scarcity
- Mass Migrations
- Decreased global stability
- Potentially increased violent conflict

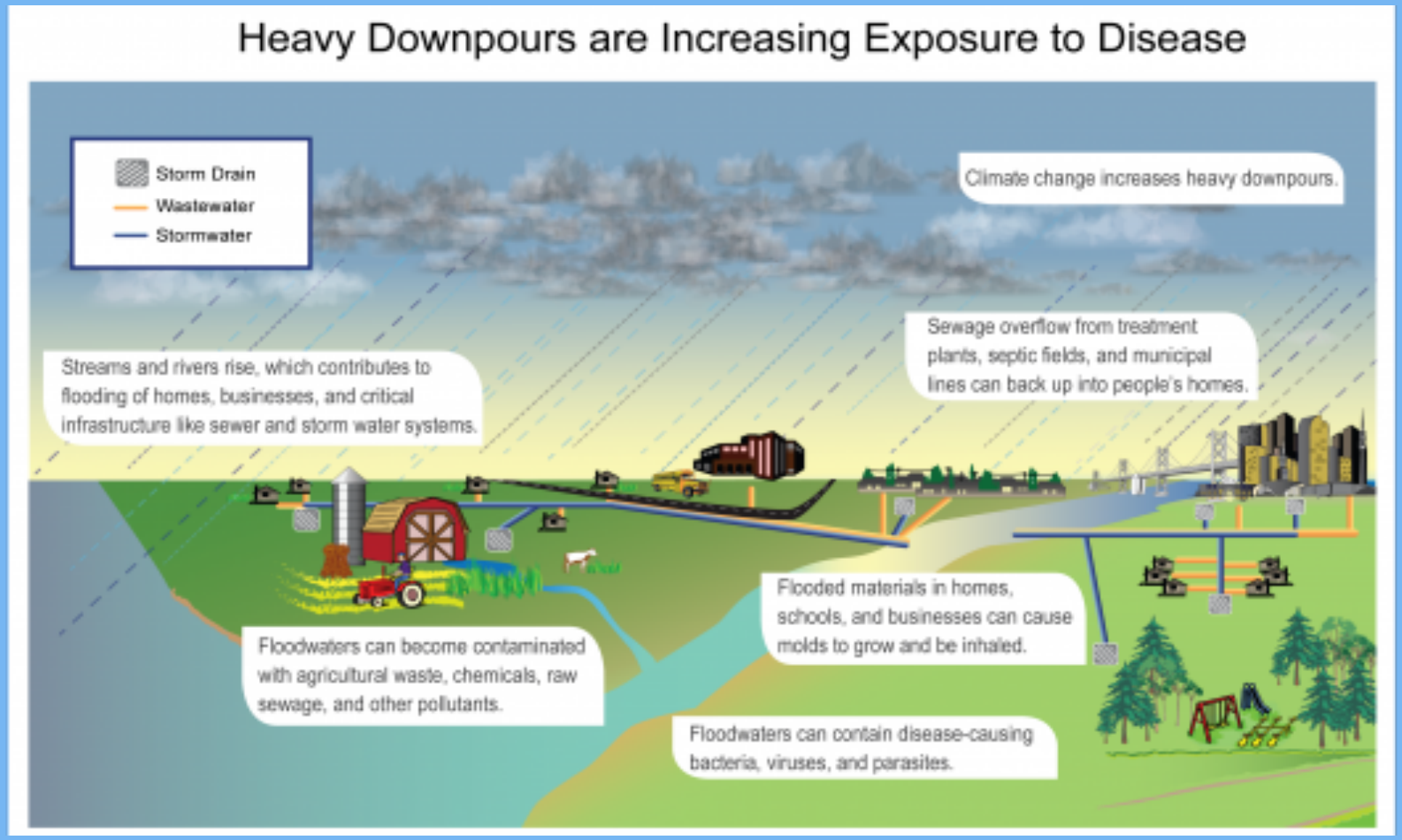
Climate Change and Infectious Diseases

- Climate sensitive infections include:
  - Diarrheal illness
    - Food and Water-borne
  - Vector borne illness
    - Lyme Disease
    - Dengue Fever, West Nile
  - Emerging Infections
    - Coccioiodomycosis (“Valley Fever”)
    - Amebic Meningoencephalitis

Climate Change and Diarrhea

- Heavy precipitation events associated with contamination of drinking water systems.
- (Nichols, *J Water Health* 2009; Curriero, *Am J Public Health* 2001; Cann, *Epidemiol Infect* 2013; Drayna, *Environ Health Perspect* 2010)
- In North America, most documented waterborne disease outbreaks occur after extreme precipitation events.
- (Uejio, *Am J Public Health* 2014)
- Heavy downpours are increasing in the U.S., and further increases are projected, raising concern for increased associated GI illness.

Climate Change and Diarrhea



Climate Change and Diarrhea

- Leading cause of child mortality across the world, approximately 1.6 million annual deaths in children < 5 years.
- Climate change projected to cause additional 48,000 deaths in children under 15 years due to diarrheal disease in 2030, primarily in Asia and sub-Saharan Africa.
- (WHO 2014)

Climate Change and Vector Borne Illness

- Multiple confounding variables.

- Impacts of human activities such as land development, time outdoors, air conditioning, self protection.

- Changes in climate influence include habitat suitability and reproductive rate for host, vector, and infectious organism.

Climate Change and Vector Borne Illness

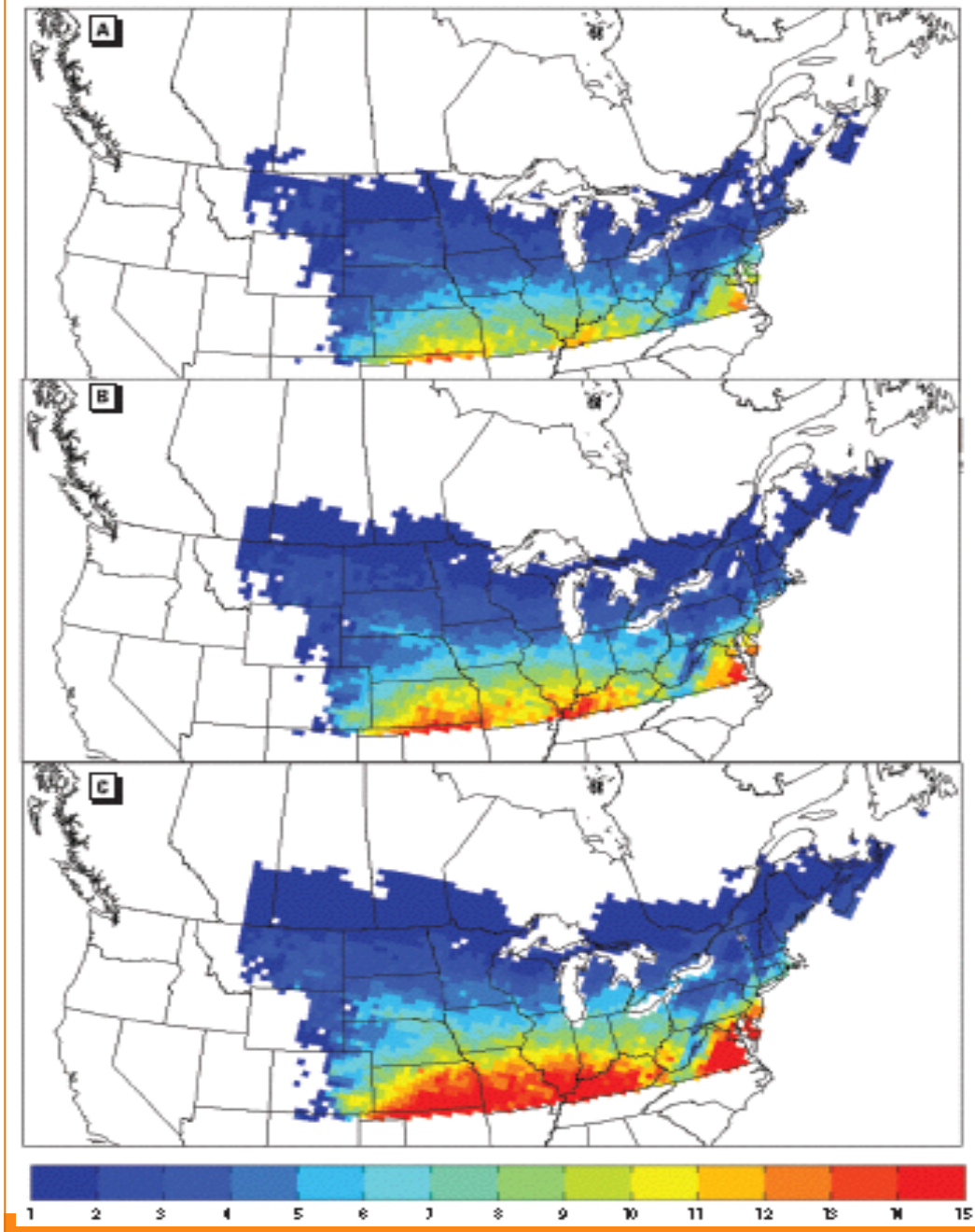
Clearest current conclusion:

- Plants and animals are moving poleward.
- They may be bringing diseases with them.

Lyme Disease

Soure: phil.cdc.gov

- Boys 5-9 years at greatest risk.
- Northward expansion of Ixodes Scapularis has been documented in North America.
- This has occurred coincident to, or after, rise in temperature in these regions, but not before.
- (Ogden, *Int J Health Geogr* 2008; Ogden, *Environ Health Perspect* 2014)



- Values of basic reproductive number of Ixodes Scapularis in Canada:
- A) estimated from observations 1971-2000
- B) Projected for 2011-2040
- C) Projected for 2041-2070

- Color scale indicates basic reproductive number (R_o).

- At threshold temperature, mortality outstrips reproduction and the tick populations die out
- (or fail to become established).

Source: Ogden, *Envir Health Perspect*, 2014

Northward Range Expansion?

Amebic Meningoencephalitis

- Caused by Naegleria fowleri, an amoeba commonly found in warm freshwater lakes and rivers.
- Minnesota reported its first case in August 2010, the third warmest for August in that region since 1891.
- Occurred 550 miles north of the previous northernmost reported case
- (Kemble, *Clin Infect Dis* 2012)

Vibrio Parahaemolyticus

- 2004 cruise ship outbreak of gastroenteritis.
- Traced to Alaskan oysters, extending the northernmost documented source of this infection by 1000 km.
- (McLaughlin, *NEJM* 2005)

Climate Change and Food Security

- Threatens the sufficiency and nutrient quality of the food supply in developing and developed countries.
- Increases risk of food insecurity and child malnutrition.

Agricultural Impacts of Climate Change

- 1) CO_2 fertilization of crops
- 2) Water availability, quality
- 3) Increasing temperature
- 4) Air pollutants, weeds, pathogens and disease
- 5) Climate extremes
- 6) Implementation of adaptation strategies

Malnutrition Impacts in Developing World

- In children < 5 years worldwide, undernutrition annually underlies nearly:
  - 3.1 million deaths
  - 1/3 of global burden disease

(Black, *Lancet* 2008)

- Compared to world with no climate change WHO (2014) projects for 2030:
  - Additional 95,000 child deaths due to malnutrition
  - Additional 7.5 million moderate or severely stunted children
  - Mostly in Africa and Asia

Nutrient Impacts

- Elevated atmospheric CO_2 changes nutrient content of C_3 food crops (wheat, rice and soybeans). Less effect on C_4 crops (maize, sorghum).
- Decreases crop concentration of protein, iron and zinc.
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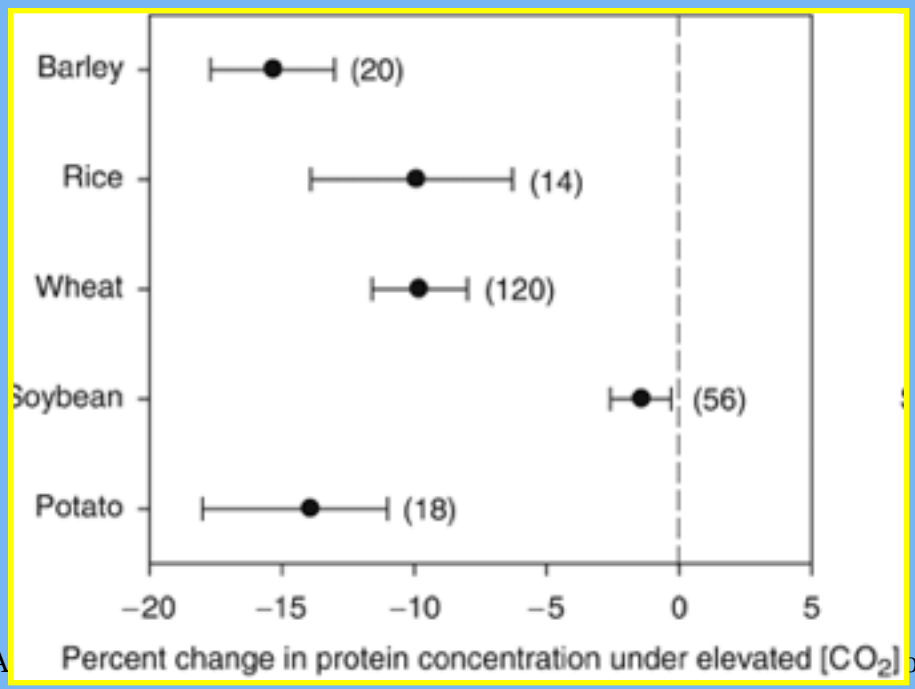
- Exact mechanism is unknown.
- This may already be occurring in current crops.

Rising CO_2 May Decrease Crop Protein



Taub, DR, Miller B, A ops: a meta-analysis. Global Change Biology 2008

- For wheat, barley and rice, protein decreases 10-15% in plants grown at CO2 levels likely for year 2100 (540-950) as compared to levels 1950-today.

Elevated CO_2 lowers Iron, Zinc in all C3 crops

(Myers, *Nature* 2014)

Iron Decrease

- Wheat: 5.1% decrease
- Rice: 5.2%
- Soybeans: 4.1%
- Field Peas: 4.1%

- Roughly 4.2 billion people live in countries where 60%-70% of dietary zinc and/or iron is from C3 crops.

Zinc Decrease

- Wheat: 9.3%
- Rice: 3.3%
- Soybeans: 5.1%
- Field Peas: 6.8%

Climate Change and Child Health

What is a general pediatrician, nurse practitioner or other primary care provide to do????

Climate Change and Child Health

- Public health initiatives have played a tremendous role in child health in the past.

- *Vaccination Programs*
- *Water Sanitation Systems*
- *Tobacco Legislation*
- *Removal of lead from paint and gasoline*

- **Pediatricians and other providers can play unique role in climate change adaptation and mitigation strategies.**

Providers and Climate Change

1. Promote education about health impacts of climate change in professional schools.

2. Reduce the carbon footprint of health facilities, including hospitals, medical offices and transport. Increase efficiency, incorporate renewables, reduce waste, and brag about it.

3. Encourage active *(walking/biking)* /shared and public transportation for office employees, provide incentives.

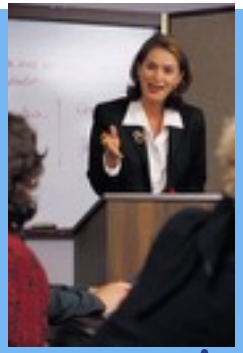
Providers and Climate Change

4. Use existing anticipatory guidance framework to discuss climate change with families.

1) Encourage walking/biking as way to promote fitness and reduce emissions.
2) Promote consumption of plant-based proteins to improve cardiovascular health and reduce agricultural pollutants.
3) Discuss with families financial and ecologic benefits of fuel-efficient vehicles and public transportation use.

Pediatricians and Climate Change

5. Become a voice for children in the climate change debate.



- 1) Advocate for policies that reduce greenhouse gas emissions, such as Obama's Clean Power Plan.
- 2) Educate elected officials on the risks climate change poses to child health.
- 3) Provide expert testimony. You now know more than they do!
- 4) Write letters to the editor, Op-Eds, or share related articles on your office Facebook/website page.

Pediatricians and Climate Change

6. Help build a broader coalition that will address climate change at local and national level.

- 1) Advocate for sustainable electricity generating systems.
- 2) Promote accessible public/active transportation and green spaces in your community.
- 3) Collaborate with health departments and research facilities to enhance surveillance and reporting of climate sensitive health impacts, and to strengthen disaster preparedness.

Climate Change and Child Health

Resources:

- American Public Health Association– Climate Change
- National Climate Assessment, GlobalChange.gov
- American Association for the Advancement of Science; *What we Know: The Reality, Risks, and Response to Climate Change*. 2014
- UNICEF- Climate Change and Children
- WHO Climate Change and Human Health
- Lancet Commission on Climate Change and Health
- NASA- climate.nasa.gov
- NOAA- noaa.gov/climate.html


QUESTIONS?